

important studies on female choice in Mecoptera. Mating in *Calopteryx* damselflies is described without mention of Jonathan Waage's studies on removal of previously deposited sperm by the penis. While R. Thornhill and J. Alcock's *The Evolution of Insect Mating Systems* (Harvard University Press, 1983) is cited in the bibliography, it appears to have been ignored in the preparation of the chapter on reproduction.

Migration and dispersal are better presented, with documentation of inconspicuous as well as conspicuous migrations and acceptance of the adaptive value of leaving adverse conditions to the migrants themselves. However, monarch butterflies do *not* have some members of their population overwintering near the Canadian border; the presentation of the seasonal cycle of aphids is garbled; and there is no mention of phases of migratory locusts and little discussion of alary polymorphism in general and the environmental and physiological factors that control it.

The short concluding chapter on success of terrestrial arthropods stresses the significance of the chitinous exoskeleton, small size, short life cycle, and "genetic adaptability," which have enabled colonization of every conceivable terrestrial habitat. Morphological adaptation is illustrated by the evolution of sucking mouthparts in insects and vertebrate ectoparasitism in ticks and insects. This chapter, regrettably, mirrors the entire book—a tantalizing peek at an important subject, not so much erroneous as incomplete and out-of-touch with modern evolutionary biology.—George C. Eickwort, *Department of Entomology, Comstock Hall, Cornell University, Ithaca, New York 14853*.

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Evolution and Adaptation of Terrestrial Arthropods.—John L. Cloudsley-Thompson. 1988. Springer-Verlag, New York, New York, 141 pp. \$33 (paper).

The phylum Arthropoda comprises, by far, the largest group of organisms on Earth. From their first appearance in the early Cambrian Period (570–480 million years before present), arthropods have radiated to fill ecological niches in virtually every corner of the globe, the Crustacea reigning supreme in many marine habitats, while insects dominate the land. It is on land that the importance of the group is manifest. In terms of species diversity and numbers of individuals, the arthropods (the vast majority of which are insects) control the nature of life on the land surface; they are

the essential middle links, the great energy transducers, in the food webs of terrestrial ecosystems. Had the group never evolved, the world would be an unimaginably different place, and this reviewer would not now be here to expound on the merits of the following book.

John L. Cloudsley-Thompson has produced a general synopsis touching on the major features of the evolution and ecology of terrestrial arthropods. According to the preface, the author's intent was not to write a comprehensive treatise, but to bring together and summarize information on the origination of the terrestrial groups and the adaptations that have led to their pre-eminent success. The intended audience is undergraduate and beginning graduate students.

Given the potential scope of the subject, the range of topics covered is necessarily broad. All of the classes, including those containing at least semiterrestrial species, are presented: Crustacea, Onychophora, Chilopoda, Diplopoda, Symphyla, Pauropoda, Arachnida, Insecta, and the non-insectan hexapods, i.e., Collembola, Diplura, and Protura. The first part of the book deals generally with the transition of the arthropods from a marine or estuarine to a terrestrial existence and the particular enabling mechanisms evolved to permit this. Chapter 1 is an overview of the phylogeny and fossil record of the land-dwelling forms, with brief mention of their aquatic progenitors. The earliest, unambiguous terrestrial animal records date from the Silurian Period, coincident with the spread of the early vascular land plants. A diverse fauna existed by Devonian times, including mites, spiders, scorpions, pseudoscorpions, centipedes, various other myriopods, and possibly insects. Insects are unequivocally represented in Carboniferous deposits.

The second chapter discusses the crucial adaptive role played by the arthropodan exoskeleton and its relationships to the size and physiology of terrestrial forms. Considerations of allometric growth (scaling), water relations, respiration, nutrition, and excretion, as they relate to the arthropodan body plan, are noted. With this background covered, Chapter 3 outlines the mechanisms involved in the transition to land of the few crustacean groups that successfully completed the trip. The chapter title, "The Conquest of the Land by Crustacea," however, is ill chosen; in their need for ready access to moist conditions for purposes of water balance, respiration, and reproduction, terrestrial crustaceans are, at best, imperfectly adapted to dry land, and in no way masters of their environments.

In the second and main portion of the book are covered the major evolutionary innovations that have allowed arthropods to become the dominant life forms on the land. Surely, the most significant of these is the evolution of flight in the insects (some 99% of species belong to the winged groups). Phylogeny of the insects and the origin of flight, including brief exposition of the various theories erected to explain it, are covered in Chapter 4. In succeeding chapters are covered the problems of reproduction, extreme environments, dispersal and migration, and defense against enemies, respectively. In a concluding chapter, the author speculates briefly on the principal adaptations responsible for the success of terrestrial arthropods, focusing specifically on two insect innovations, chosen to exemplify the adaptability of terrestrial arthropods: the evolution of sucking mouthparts, which have permitted access to a broadened range of life styles and diets (e.g., parasitism, pollination; blood, plant sap, nectar); and the adaptations inherent in an ectoparasitic way of life, illustrated by lice, fleas, and the bed bug.

Cloudsley-Thompson has produced a brief, mostly superficial discussion of the main problems involved in terrestrial arthropod existence. As such, the work will largely fulfill his prefaced objective, and serve primarily as a serviceable introduction to arthropod evolutionary ecology for college-aged zoology students and, perhaps, as a refresher for those a bit more knowledgeable in the field. For others, particularly practicing researchers, the book is clearly inadequate as a reference work. A number of important recent papers, which should have been included in a work of this nature, are not cited. For example, no reference is made in Chapter 1 to Retallack and Feake's discovery of evidence for a possible Ordovician age for the first terrestrial arthropods (*Science* 235:61-63, 1987). Surprisingly, Kingsolver and Koehl's brilliant hypothesis for the origin of the insect wing (*Evolution* 39:488-504, 1985) is absent from the discussion of insect flight in Chapter 4. In the section on cave life (Chapter 6), no mention is made of F. G. Howarth's major contributions to the study of cavernicolous arthropods (e.g., *Annual Review of Entomology* 28:365-389, 1983). In the discussion of diapause in the same chapter, there is no citation to Tauber, Tauber, and Masaki's exhaustive review (*Seasonal Adaptations of Insects*, Oxford Univ. Press, 1986), which covers the subject extensively. At the very least, mention of these significant sources could have been included as notes added in proof.

The literature included in bibliographies following each chapter is predominantly British (almost 60%), and comprises much somewhat dated, marginally relevant work, particularly that on flight. Also, apart from the many annoying typographical errors, which betray a lack of careful proofreading, errors of fact and interpretation appear. As examples, Cloudsley-Thompson reports (p. 124) that the sources of honey bee alarm pheromones are unknown. In fact, the glands producing these chemicals, associated both with the mandibles and the sting, have long been known and are well characterized, as summarized in M. L. Winston's recent review (*The Biology of the Honey Bee*, Harvard Univ. Press, 1987). And the author's hurried discussion of the attributes contributing to arthropod success on land (Chapter 9) was better and more elaborately framed a decade ago by Eisner and Wilson (*The Insects*, Freeman, 1977).

Lastly, the price of the book, at \$33.00 for the paperback version, may tend to place it somewhat out of reach for many potential readers, particularly students. In view of its shortcomings, one might well balk at paying such a price for such a cursory, incomplete treatment. Cloudsley-Thompson has a long, well deserved reputation for solid, scholarly work in arthropod ecology. One would expect rather more of him in producing this book.—*Thomas W. Culliney, 46 Vineyard Road, North Haven, Connecticut 06473.*